Teaching Machines and Programed Instruction

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Role of Peer Influence and Aspects of Group Use of Programed Materials [1]

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PROBLEM Two apparent shortcomings exist in the classroom use of linear programed textbooks. First, knowledge of results (KR) are ineffective reinforcers in maintaining student attention and effort (2, 6). Second, students have difficulty in applying the information and knowledge acquired through reading a programed textbook (8). Eldred (3) summed up this point well when he stated that ". . . when the students were asked to write a theme or to perform an experiment in science—in short, to apply what they had learned (through programs)—we found little evidence that they had ever studied that particular subject or portion of a subject."

The above shortcomings might be reduced if (1) an extra-program reinforcer could be used, and (2) the classroom teacher were to follow the reading of a programed textbook with extra-program experiences enabling students to apply the program.

An obstacle preventing the classroom teacher from providing the necessary experiences is the relatively chaotic condition that

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exists when students are reading a program under individual self-paced conditions. One student is on frame 320, a second is taking a test, while a third has finished the program and is awaiting another assignment. If the teacher is going to teach students to apply the programed material, steps must be taken to provide her with the opportunity to work with groups of students, preferably groups that are relatively homogeneous, i.e., achieve comparable scores on tests covering the programed material. For such homogeneous groups, she could provide extra-program experiences that were specific and concentrated.

It has been demonstrated in two studies that programed materials can be used effectively with groups (1, 4).

Carpenter (1) compared learning under individual-paced conditions at the college level and found that programed materials "can be pre-paced and presented to groups of . . . students without significantly reducing the learning that occurs under conditions of self-paced and individual study." Another important finding was that the medium through which the programed material was presented had no differential effect on learning; students learned equally with programed textbooks, teaching machines, or television.

Frye (4) used programed materials with "homogeneous and heterogeneous" groups. With both groups, each frame of programed material was projected on a screen, but the preferred response was not presented until all members of the group pressed a button to indicate they had responded. In each group, the slowest member determined the group pace. With the heterogeneous group, this procedure was ineffective; differences in response time were too great. With homogeneous groups, however, the procedure was found to be effective.

The writer has used programed materials under pre-paced group conditions similar to those employed by Carpenter and Frye. He found student performance and behavior to be similar to that which obtains when a programed textbook is being used. On tests of retention, students were able to answer only superficial multiple-choice questions. They were also quite vocal in complaining about the programs being "boring."

This study differs from the above studies in that it required a greater degree of involvement by the program-reading Ss. Rather than merely covertly reading and responding to the program frames, Ss read the program frames as members of a group and

took turns in responding "out loud" as the frames were flashed on a screen. This meant that the pace of the group was determined by the time the individual Ss took to read and respond to the frames.

It was hypothesized that the peer influences generated by the group condition would sustain student attention and effort, and that the results of such attention and effort would have two effects: an increase in learning over that occurring when the programed textbook is studied under the individual self-paced condition, and emergence of a group of students with retention scores sufficiently similar to justify their being labeled "homogeneous."

For purposes of comparison, a comparable group of students read the same program under individual self-paced conditions. The independent variable was the study condition, i.e., group versus individual, and the dependent variable was the scores on tests that attempted to measure Ss' ability to apply the programed textbook.

METHOD
Material
The linear programed textbook used in this study was the *U. S. Constitution* (7). The program has 923 frames and takes approximately five hours to complete. All Ss took six tests which covered the programed textbook. The first test was a simple multiple-choice test provided by the publishers. The five remaining tests were developed by E and were designed to measure how well Ss could apply the program *U. S. Constitution*. The main reason for selecting the *U. S. Constitution* for this study was that it covered a subject area in which local educators are interested and regarding which cooperation for the study could be more readily obtained. A second reason was that the program is cumulative and a S's attention and effort must be continuous if he is going to be able to respond correctly when called upon in the group condition.

Subjects
Two complete eighth grade classrooms were used. Both groups were above average, both academically and socioeconomically. One classroom (N=26) was from a university laboratory school and had a mean IQ of 123 (SD=10). The second classroom (N=32) was from a local public school and had a mean IQ of 127 (SD=7). The public school places students in tracks; Track 5 is the lowest level and Track 1 is the highest level. The classroom in this study was at the Track 2 level.

Procedure
The classroom with 26 Ss was selected to read the program *U. S.*

Constitution under individual self-paced conditions for approximately 30 minutes each school day. All Ss were told to respond covertly, i.e., say the response to themselves. No extra assignments or homework of any kind were given. The classroom teacher and E remained unobtrusive throughout the study and interacted with Ss only when a S asked a question. E stayed out of the room as much as possible. (Hereafter, the classroom reading the program *U. S. Constitution* under individual self-paced conditions will be referred to as the Textbook group.)

The other classroom (N=32) read the program *U. S. Constitution* under group conditions using a 35mm filmstrip projector. Each frame in the *U. S. Constitution* was placed on 35mm filmstrip. The first program frame flashed on the screen was the one to which a given S was to respond by saying out loud what he felt should go in the blank(s). The following frame contained the question frame with the preferred response inserted in the blank(s). Thus, the preferred response, which was presented after a S's verbal response, was always shown in the context of the total frame.

This classroom (hereafter referred to as the Projector group) was randomly subdivided into two 16-S subgroups having an equal number of males and females. To minimize the possibility of the Ss' believing they were in the "dumb" or "smart" groups, Ss were randomly assigned to the groups in front of the total class.

There were several reasons for dividing Projector Ss into two groups. Three groups in one classroom would be awkward and the groups would be overhearing each other's verbal responses. One large group of 32 Ss would minimize individual involvement since each S would respond only once to every 32 frames. Although there are no data available to aid in determining optimal group size, E has found that if groups are small, e.g., five or six, Ss become less sensitive to group pressures. A final decision by E was to use two groups of 16 Ss and allow them to work together in opposite parts of the room.

Prior to allowing the Projector groups to meet in their assigned areas of the classroom, a few of the initial frames of the *U. S. Constitution* were flashed on the screen and Ss were shown what they were expected to do. After this brief demonstration, Ss met with their respective groups and were given a number by each of the two projector operators, i.e., the classroom teacher and E,

and were told to respond out loud to the program frame exposed on the screen when their number was called. If they did not have an answer to the exposed frame, they were to say, "I don't know." It was emphasized that each *S* should speak loud enough to be heard by members in the group. Order of responding was determined by a random list of numbers which each projector operator had before him.

One important point attended the manner in which Projector *S*s were called upon to respond. If a *S*'s number were called out at the same time a program frame was presented, other *S*s might not be attentive to the frame since they were not responsible for responding to it. To minimize this effect, the projector operators agreed to read each frame to themselves and use that interval as a measure of the time necessary for *S*s to read the frame. At the end of this interval, the operator called out a given *S*'s number. If that *S* had not been reading the frame, he would have to read it while other *S*s waited, squirming in their seats and staring at *S* while he read the frame. It was felt these behaviors would be sufficiently aversive so that all *S*s would read the frame during the desired interval and that when they were called upon, they could make the necessary response almost immediately.

*S*s in the Projector and Textbook groups were told at the start of the study that they would take six tests, the first one being an easy test and the remaining five being quite difficult. *S*s were told also that there would be no lectures, recitations, and homework; that the programs were their only source of information.

From a time standpoint, study conditions differed for Textbook and Projector groups. Textbook *S*s read the program for as much as 30 minutes a day. Projector *S*s read the program for as much as 45 minutes a day. The study was done in two phases, with the Textbook phase being completed before the Projector phase was begun.

Attitude Evaluation. Two techniques were used to measure *S*'s attitudes toward the programed materials. The first consisted of a series of five short sentence stems which each *S* was asked to complete. The completed stems were categorized by a disinterested rater who rated each completed sentence as either positive, negative, or neutral.

The second instrument was a 12-item scale, with the *S* having to check one of five categories. The scale was discovered by E after the Textbook phase was complete and was not given to

the Textbook Ss. The questionnaire was completed by only the Projector Ss.

Results   Table 1 shows the Projector and Textbook means, standard deviations, mean differences between groups, and the significance of those differences.

Of all six mean differences, the difference between means was most extreme on Test 2. That 60-item test was a difficult test as evidenced by the Projector mean of 18.3 and Textbook mean of 25.6. The mean difference of 7.3 was significant beyond the .01 level.

An appraisal of this large difference is important at this point. At the start of the study, both groups were told that all tests except Test 1 would be quite difficult. After the relatively easy Test 1, Ss probably were reluctant to accept the E's admonitions. With the Textbook group, Ss took tests individually and it was probable that early test-takers informed other Ss how difficult Test 2 actually was, causing them to review the program frames more intensely. With the Projector group, forewarnings of the test's difficulty was not possible since all Ss in that group took Test 2 at the same time. Thus, Projector Ss probably learned of the test's difficulty the hard way: by actually taking the test.

The plausibility of this explanation is enhanced by the mean differences for Tests 3, 4, 5, and 6. On those four tests, means between Projector and Textbook groups were small in relation to the 7.3 mean difference on Test 2. Also, on those four tests, the only mean differences that were significant occurred on Tests 3 and 4, with the Projector means being significantly greater than the Textbook means.

A second evaluation involved a comparison of the Projector and Textbook variances. The purpose of making such compari-

TABLE 1

Means and SD's Six Tests Over the U. S. Constitution

Test No.	1		2		3		4		5		6	
Total Points	29 pts.		60 pts.		20 pts.		24 pts.		35 pts.		8 pts.	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Projector	25.7	1.8	18.3	4.2	12.5	2.1	11.5	2.9	17.1	4.3	3.5	1.4
Textbook	24.6	3.3	25.6	8.6	10.2	2.9	9.0	3.5	16.3	4.0	4.8	1.7
Mean Difference	1.1		—7.3**		2.3**		2.5**		0.8		—1.3	

** p < .01.

sons was to determine whether Projector Ss were more similar or homogeneous on the six tests. Although the emergence of significant F ratios would lessen the justification for making the above t tests of mean differences, the t test is considered sufficiently robust to be used if departures from homogeneity are not extreme (9).

Table 2 shows the variances for the Projector and Textbook groups and the corresponding F ratios. Overall, the first three ratios were significant, the first two beyond the .01 level and the third beyond the .05 level. The ratios on the last three tests did not approach the .05 level of significance.

On only one test, Test 5, was the Projector variance greater than the Textbook variance.

Because the ratio of variances is relatively large on Test 2, some caution is necessary in evaluating the t ratio in Table 2 which compares the mean difference for Test 2.

Subject Attitudes. Percentage of positive, neutral, and negative responses to five sentence stems are shown in Table 3. Projector Ss were slightly more positive and less neutral than the Textbook Ss. Percent of negative statements were similar.

Table 4 shows data on the 12-item inventory which only Projector Ss finished. An overall evaluation of the inventory indicates that Projector Ss felt that they were kept interested and at-

TABLE 2

Variances on Six Tests Over the U. S. Constitution

Test No.	1	2	3	4	5	6
Projector	3.5	17.7	4.2	8.7	19.2	1.8
Textbook	11.2	74.0	8.5	11.5	15.6	3.0
Ratio Max. / Min.	3.2**	4.2**	2.0*	1.3	1.2	1.6

* p <.05.
** p <.01.

TABLE 3 Percent of Positive, Neutral, and Negative Statements on a Sentence Completion Form		*Pos.*	*Neut.*	*Neg.*
	Textbook	34	21	45
	Projector	45	13	42

TABLE 4

Attitude of Projector Subjects (N=32)

The statements below represent attitudes toward the use of programed materials as a means of studying a subject. Symbols used are: SA (Strongly Agree), A (Agree), U (Undecided or Neutral), D (Disagree), or SD (Strongly Disagree).

Numbers indicate percent *Ss* selecting the given category.

		SA	A	U	D	SD
1.	Classes in which programed materials are used are dull and un-interesting.	4	14	25	29	29
2.	I feel that using programed materials is the most effective method of studying that I have ever used.	11	11	25	29	25
3.	I am glad that I am not using programed materials in more classes than I am at present.	18	21	21	25	14
4.	I do not like to work with programed materials.	14	11	11	29	36
5.	School would be more interesting if programed materials were used in more classes.	7	21	25	29	18
6.	I wish that I could study programed materials in my other classes.	11	18	18	25	29
7.	Using programed materials results in too much wasted time.	11	4	14	21	50
8.	Using programed materials is interesting because you have to keep thinking.	18	46	14	14	7
9.	I would rather be working with a group of classmates than working alone with a programed textbook.	29	46	18	4	4
10.	When I use programed materials I can keep interested in my work.	14	37	7	21	18
11.	When I use programed materials I understand everything that I study.	—	11	25	37	25
12.	I would rather have a teacher explain the subject than be left on my own with a programed text.	18	11	32	21	18

tentive (see items 1, 7, 8, and 10) but that they were not particularly satisfied with the projector condition as a means of learning (see items 2, 5, 6, and 11).

Table 5 shows the time needed for completion of the program. The Textbook mean was 297 minutes (SD=43). The Projector mean was 349 minutes. Before the study began, the classroom teacher and E agreed to have the Projector *Ss* spend the whole period reading the *U. S. Constitution*. The median time for the 12 sessions was 34 minutes. It should be added that once Projector *Ss* began reading the *U. S. Constitution*, no pauses or breaks were provided. On two of the 12 sessions, *Ss* read the program continuously for 45 minutes.

TABLE 5		Minutes
Time Spent Reading the U. S. Constitution	Projector	349
	Textbook	297*

* SD = 43 minutes.

CONCLUSIONS AND IMPLICATIONS

The major objective of this study was to compare learning under group conditions with learning under individual self-paced conditions. The data support the conclusion that the classroom of Ss reading the program U. S. Constitution as it was projected on a screen did as well, and often better, than Ss who read the same program at their desks at a rate each S selected. Also, there was some evidence that the Projector Ss tended to be more homogeneous on the tests of retention since three of six test variances were significantly less for the projector condition than the textbook condition. Some caution is needed here since the Projector Ss were probably more homogeneous to begin with due to their school's use of a track system, the major purpose of which is to generate classrooms having students of comparable abilities.

Certain suggestions can be given regarding the group use of programed materials. First, the program flashed on the screen should be one which requires the S to read the whole frame in order to make the response. On this count, the U. S. Constitution was extremely weak. Many of the responses were trivial and a given S could easily make the preferred response after being called upon by merely reading a few of the words on each side of the blank. Recent work by Holland and Kemp (5) is pertinent to this problem, for they have found that as much as 69 percent of programed material can be blacked out without reducing the error rate. The implication for the study reported here is that making the preferred response did not demonstrate that S had read and was responding to all of the material in the program frame.

The group procedure also requires a program that is cumulative. Ss soon discover that once they have responded, it will probably be some time before they are called upon again, especially if there are as many as 15 Ss in a group.

A program that is cumulative requires that successful responding to a given frame be predicated upon retention of the content in previous frames. The program U. S. Constitution satisfied this cumulative requirement, but the cumulative effects were re-

duced by the relative ease of making the preferred response. The frames were over-cued and it was possible for S to make the preferred response from the cues within the frame. There should be cues within a frame, but such cues should be useful only when used in conjunction with information acquired through mastery of preceding frames. In the group use described here, a S who had not attended to the, say, 14 frames occurring since he last responded should be completely incapable of making the preferred response. If he fails to attend to those 14 frames, he should suffer the punishing effects resulting from having to say "I don't know," rather than receiving the reinforcing effects of peer approval for a trivial response.

While on the topic of attention and effort, it should be pointed out that comparisons of the Projector group's performance on Test 2 with Tests 3 through 6 cast some doubt upon the reinforcing effects of peer approval. Test 2 was the first difficult test taken by Projector and Textbook groups. On that test the Textbook mean was significantly higher than the Projector mean. As indicated earlier, Projector Ss had no forewarnings of the test's difficulty as did Textbook Ss who took the test individually. Thus, early test-takers in the Textbook group were probably able to apprise later Ss of the test's difficulty. After Test 2, Projector means either equalled or exceeded Textbook means. This suggests that the consequences generated by the tests were the "cause" of subsequent improvements in test performance rather than the peer approval.

Regardless of the ex post facto evaluations of peer approval and/or scores on tests as being the "cause" for improved test performance, the results on Tests 3 through 6 still indicated that Ss reading under the projector conditions could equal or exceed Textbook Ss on tests measuring application of the programed learnings.

An interesting feature of the projector condition was the frequent opportunities that presented themselves for the classroom teacher to discuss the program's content. Throughout the projector presentation of the *U. S. Constitution*, innumerable opportunities arose in which the classroom teacher could have paused and related what was being read with topical events. Although this was not to be allowed to happen during this study, it is a virtue of the group use that the classroom teacher can stop whenever she feels like it and pursue a particular topic in depth.

For the competent and interested teacher, myriad opportunities exist to relate the *U. S. Constitution* to daily events appearing in the newspaper or over television.

The attitude measures used suggest that Ss prefer programs on some limited basis, preferably in conjunction with the classroom teacher. The evidence is strong that they do not want prolonged exposure to programs. It is difficult to evaluate data obtained through questionnaires, particularly with respect to determining cause and effect relationships. For example, it is possible that the projector condition was too demanding in that Ss had to be attentive constantly to the program frames as they were flashed on the screen. With teacher recitations and lectures, it is possible to relax occasionally and to allow one's mind to wander without having to suffer aversive consequences such as not making a correct verbal response.

Recommendations   Recommendations for teachers or researchers planning to use programs under group conditions are as follows:

1. Develop or rewrite existing programs so that only a sentence or two appears on the screen at one time. Short frames require more responses and keep Ss attentive through the continued exposure of program frames, any of which may be paired with a given S's name.

2. Use programs with a variety of different size groups to determine what size makes for optimal learning. Large groups minimize the opportunity for Ss to respond, while small groups tend to minimize peer pressures.

3. Make sure the program material is cumulative. If Ss sense that continued attentiveness is essential, they will be more likely to attend.

4. The best single criterion for determining whether to use a program under group conditions is the success of the programed textbook itself. Its value and acceptance under the group condition is, in my opinion, directly proportional to its effectiveness when read in programed textbook form. Placing programs on film requires a lot of time and effort, and I have learned the hard way never to place programed materials on film until I have: (a) studied the program intensively myself and written a variety of test items that measure what I feel the program can teach, and (b) used the programed textbook with a variety of students.

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